GROUND CONDUCTIVITY AND ITS EFFECT ON MW GROUNDWAVE PROPAGATION

Factors affecting 160-meter groundwave communication range

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- The 160-meter band is what we consider a medium-wave (MW) frequency.
- It shares the same characteristics as the high AM broadcast frequencies and is, in fact, adjacent to the AM Expanded Band
- Both groundwave and skywave propagation modes occur
- Local/regional communication can take place via NVIS skywave, groundwave or a combination of the two

THE 160-METER BAND

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- Many hams confuse ground conductivity with ground resistivity
- Ground that has very low resistivity at DC/60 Hz can exhibit terrible conductivity at RF frequencies
- Seawater represents the highest value of "ground" conductivity found in practice at 5,000 mS/m
- "Good" conductivity values range from 8 to 30 mS/m and are typical of rich soil
- "Fair" conductivity values range from 4 to 8 mS/m and are found in wooded areas and seacoasts
- "Poor" conductivity values are those below 4 mS/m and are found in mountainous and rocky areas (Rocky Mountains, Appalachia, etc.)

WHAT IS GROUND CONDUCTIVITY?

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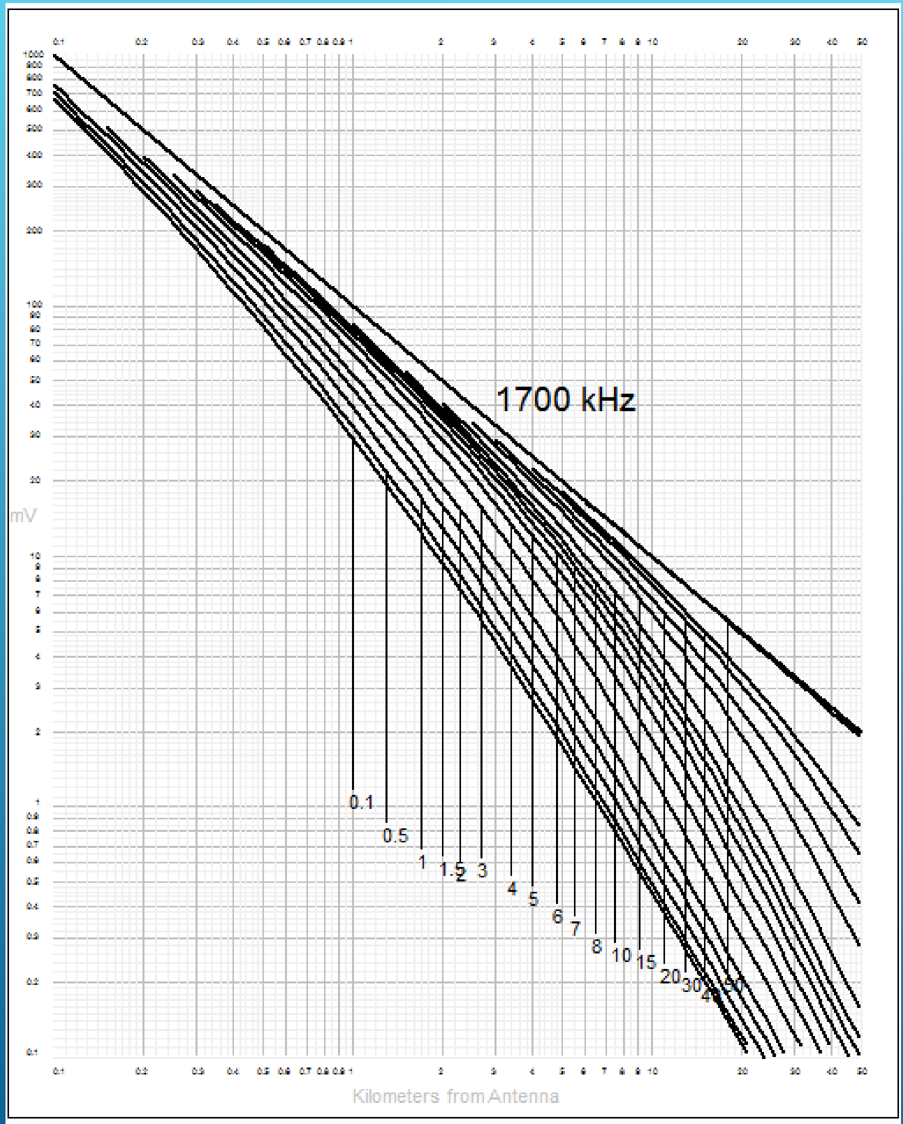
- The depth of penetration is dependent on frequency, dielectric constant and conductivity
- 5 to 10 feet at shortwave frequencies
- 50 feet or more at 160 meters and below
- Surface conditions have more effect at higher frequencies
- Attenuation of groundwave signals is inversely proportional to conductivity
- Conductivity has a greater effect at higher frequencies

EFFECTS OF CONDUCTIVITY ON PROPAGATION

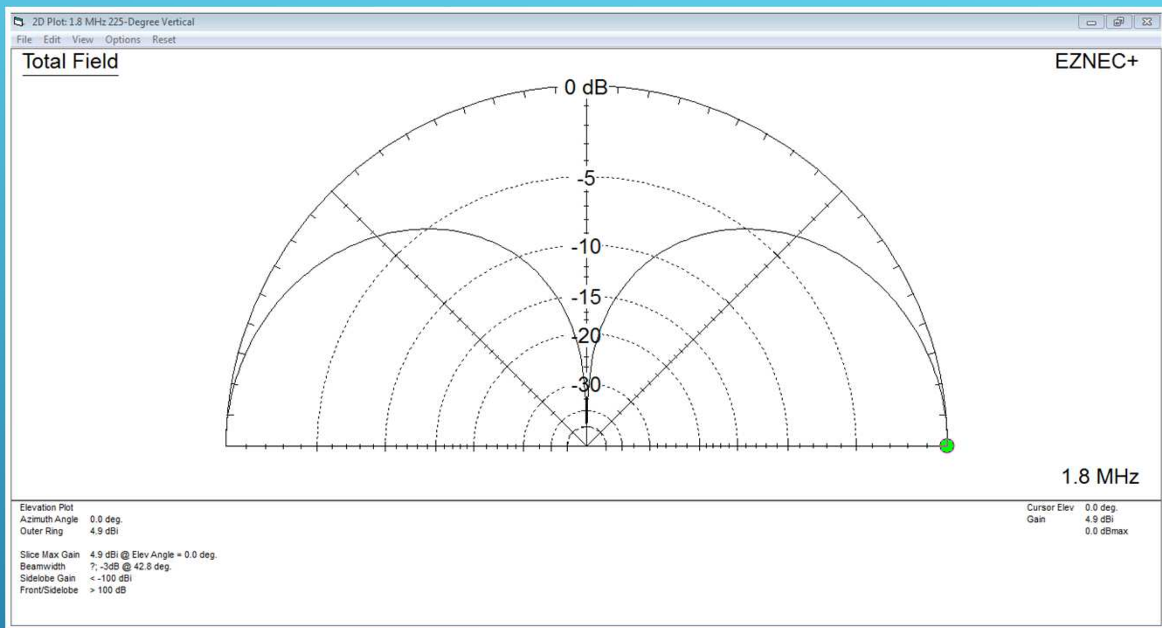
- The field radiated from an antenna follows an inverse distance rule
  - Over perfectly-conducting earth, the field at any point will be inversely proportional to the distance from the antenna
  - The field at 2 km will be exactly half that at 1 km
- Less-than-perfect ground will modify this relationship
  - Attenuation
  - Follows a curve

INVERSE DISTANCE FIELD


1700 kHz
mV
Kilometers from Antenna
0.1
0.5
1
1.5
2
3
4
5
6
7
8
10
15
20
30
40
50

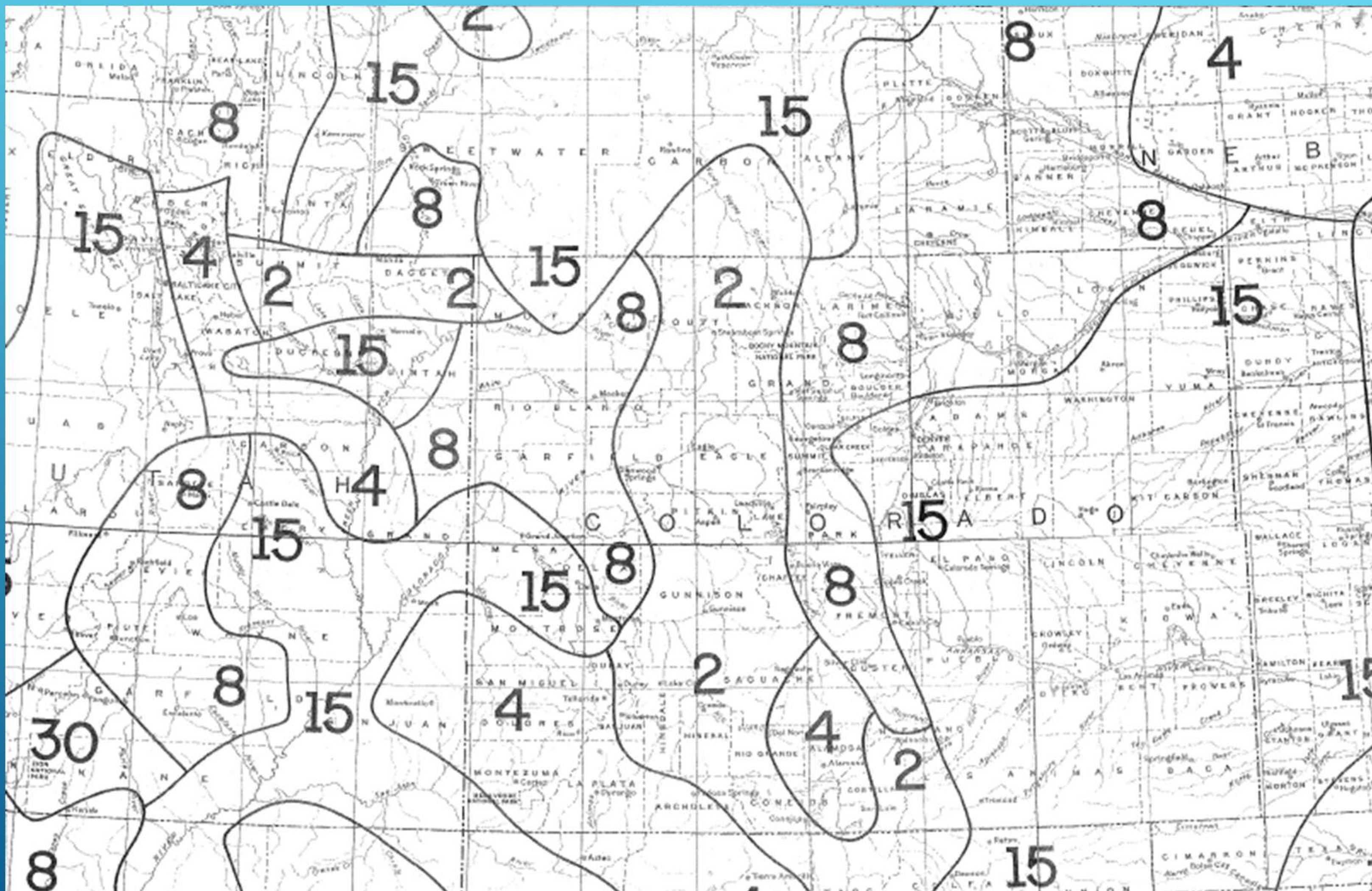
- While any reasonable antenna configuration will work, experience has shown the monopole vertical antenna to be one of the best configurations for “top band” operation
- An 80-foot tower represents a 53-degree radiator on 1.8 MHz
- With a reasonable number of radials 80-100 feet long, an inverse distance field (IDF) of 245 mV/m per kilowatt of input power can be expected
- Base impedance of an insulated 80-foot monopole is about 11 ohms at 1.8 MHz.
- A wire “skirt” can be used on a grounded tower.

A TYPICAL 160-METER ANTENNA



VERTICAL PLANE PATTERN OF AN 80-FOOT MONOPOLE

M3 Map of Colorado



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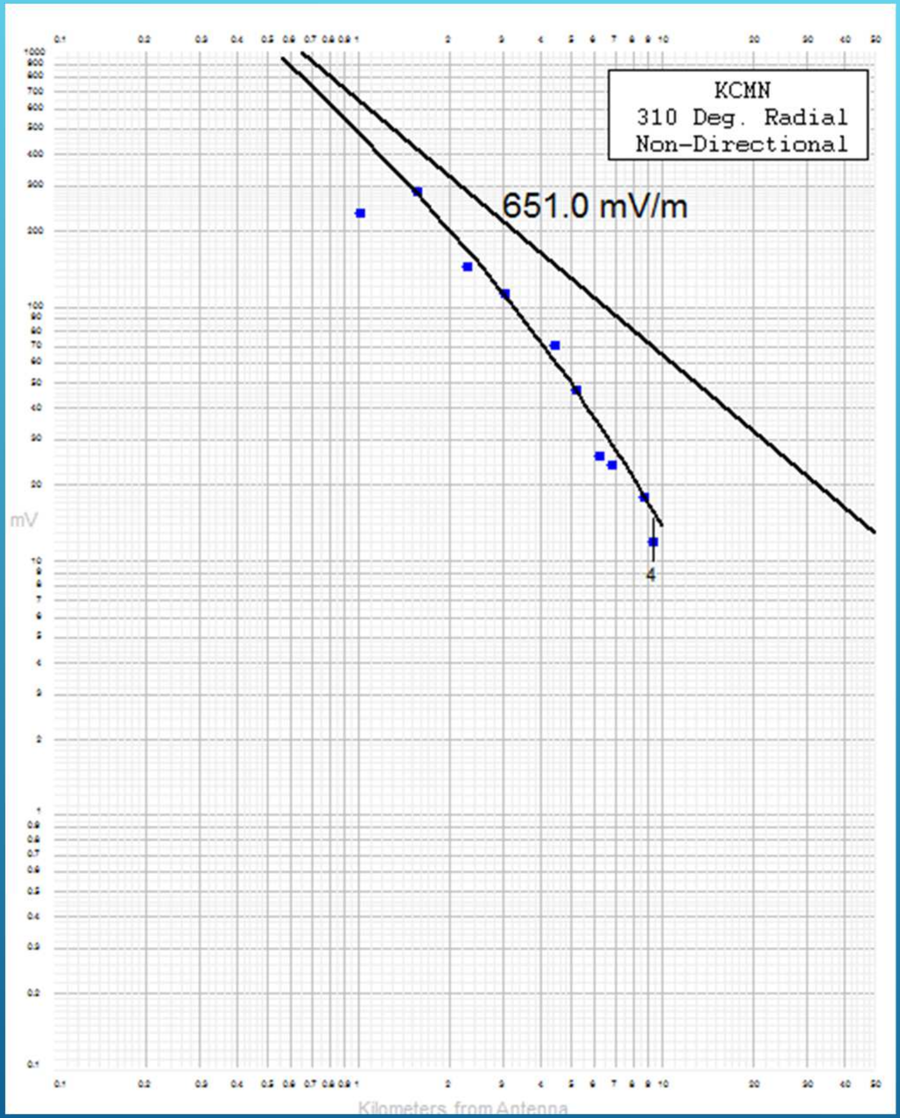
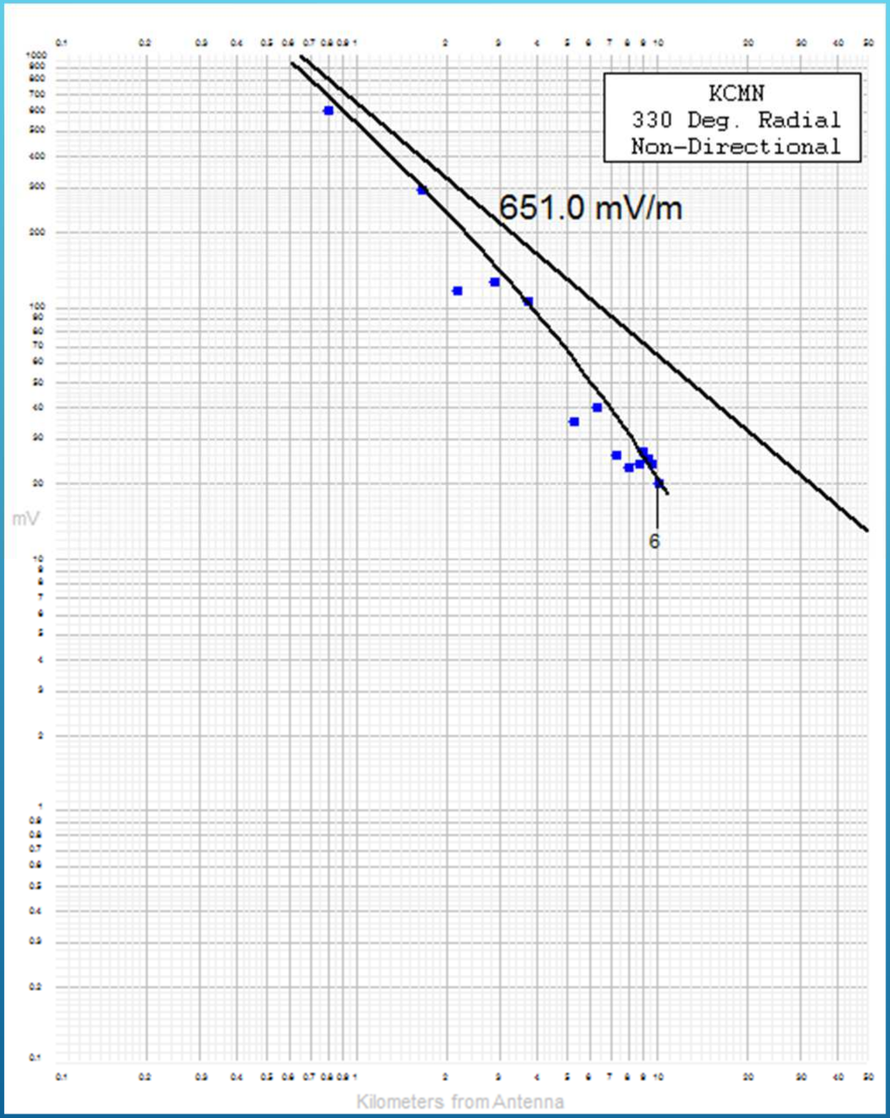
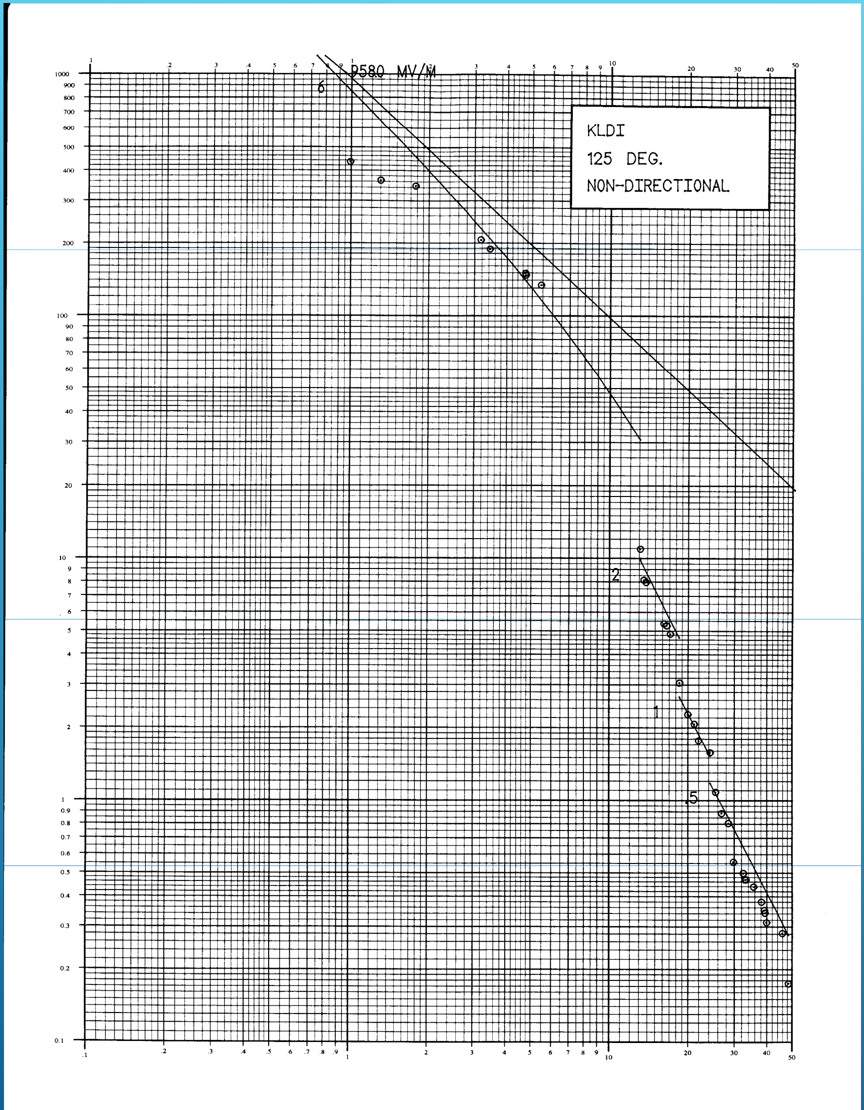
Typical Measured Conductivity Graph



Typical Measured Conductivity Graph



KLDI – Laramie, WY 125 Degree Measurements



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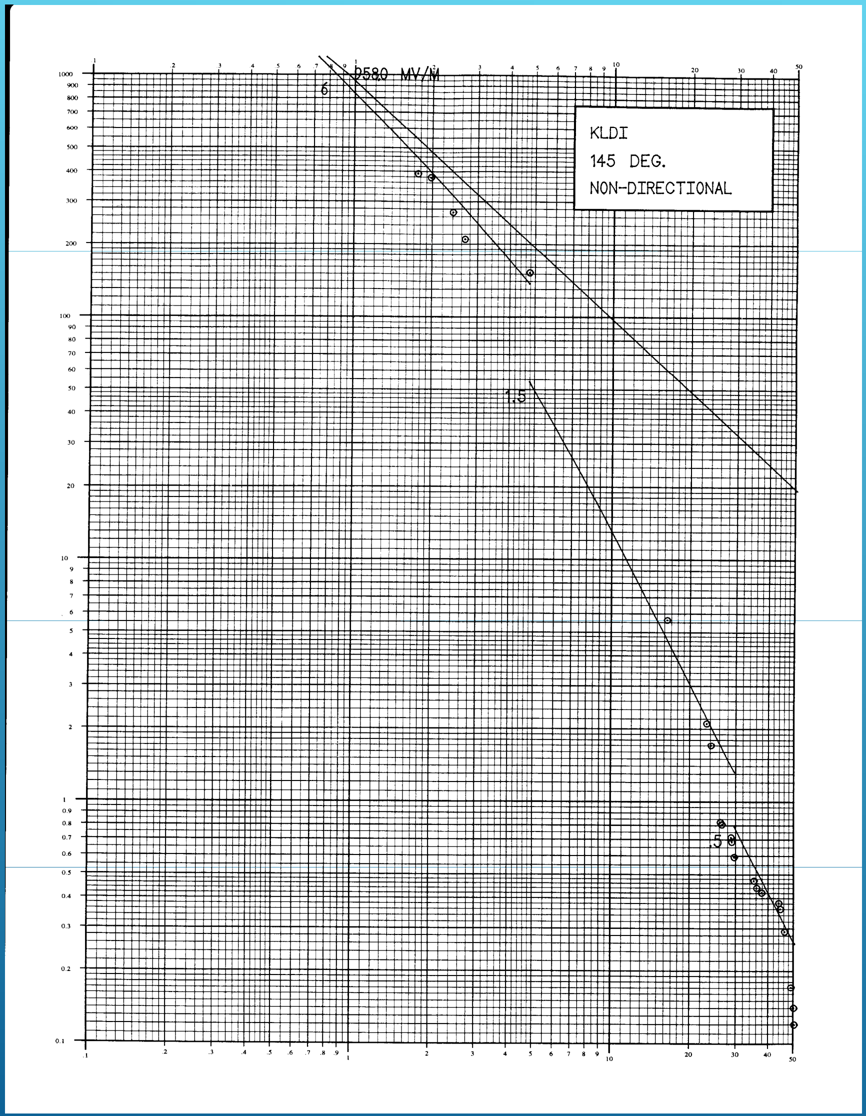
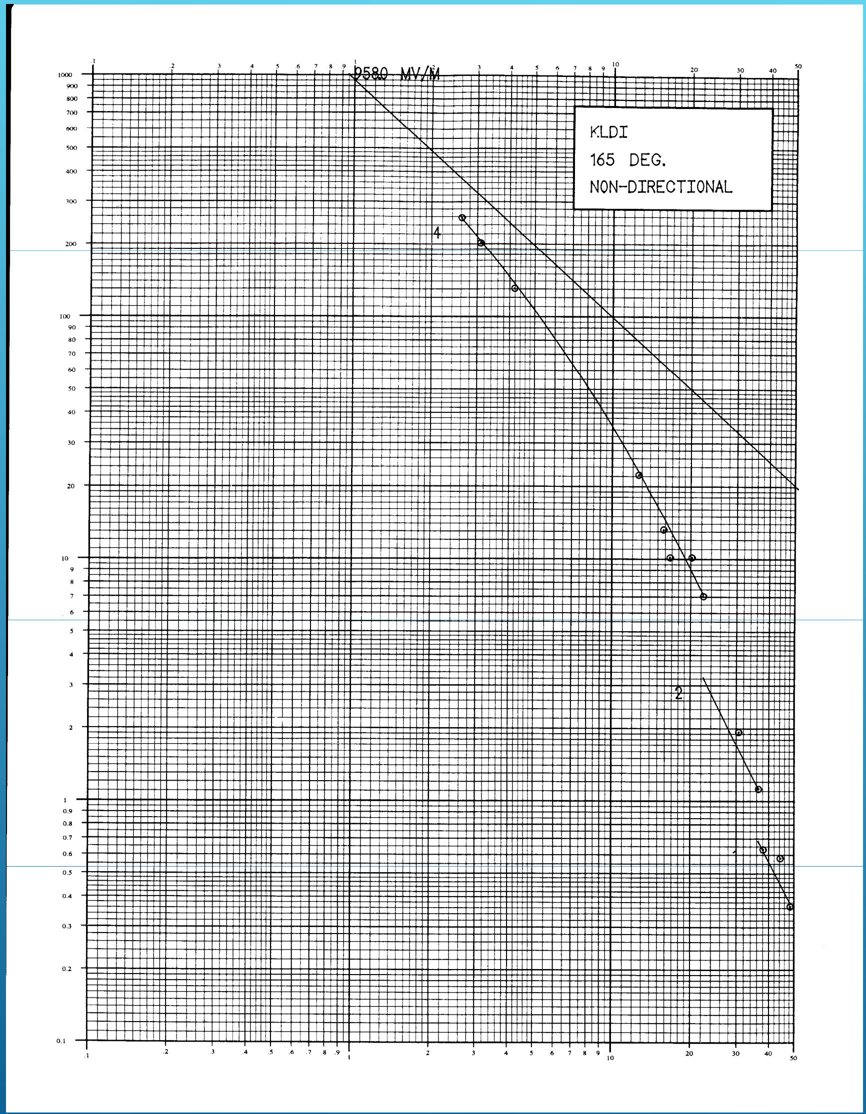
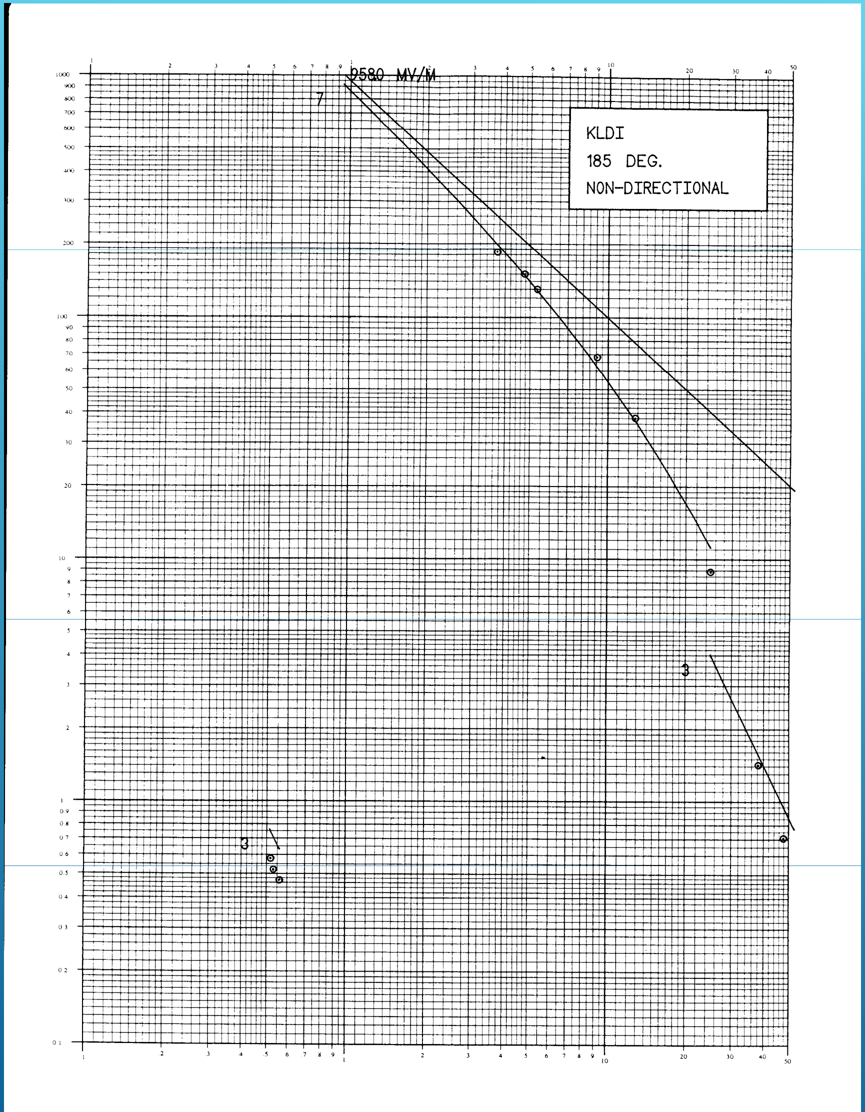
KLDI – Laramie, WY 145 Degree Measurements



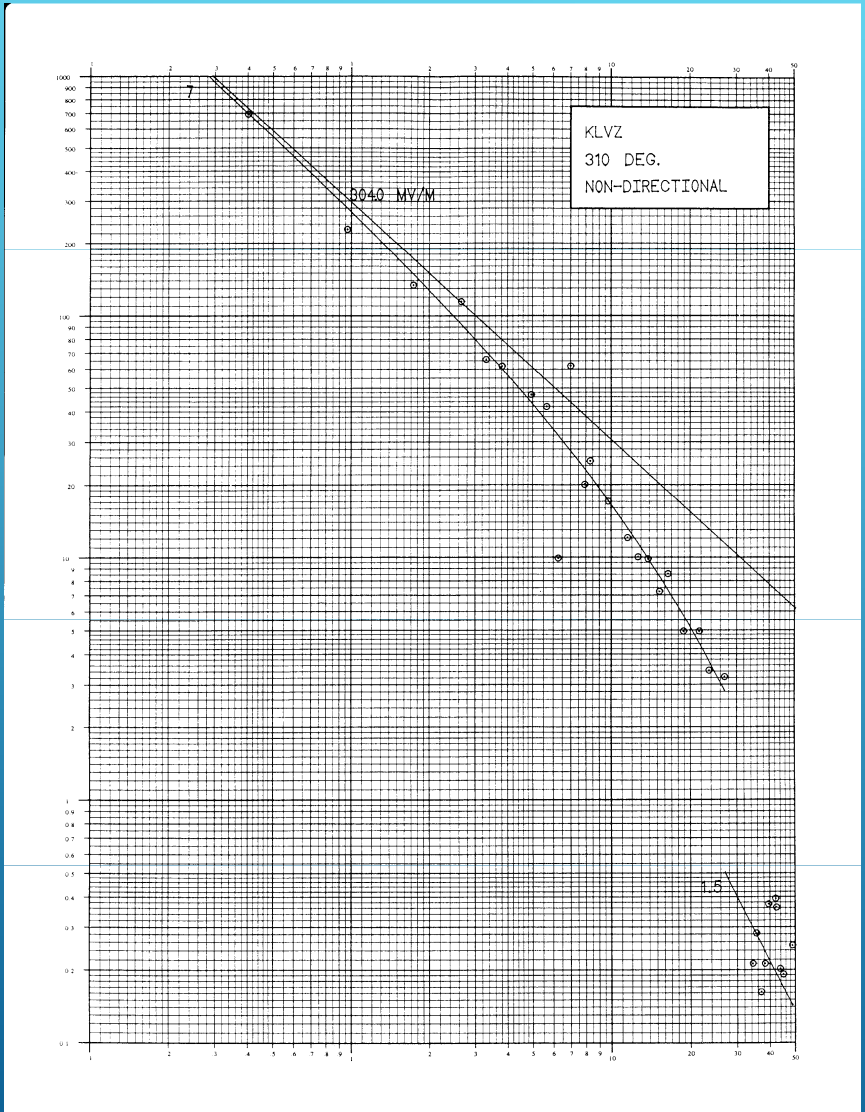
KLDI – Laramie, WY 165 Degree Measurements



KLDI – Laramie, WY 185 Degree Measurements



KLVZ – Ruby Hill Site – 310 Degree Measurements



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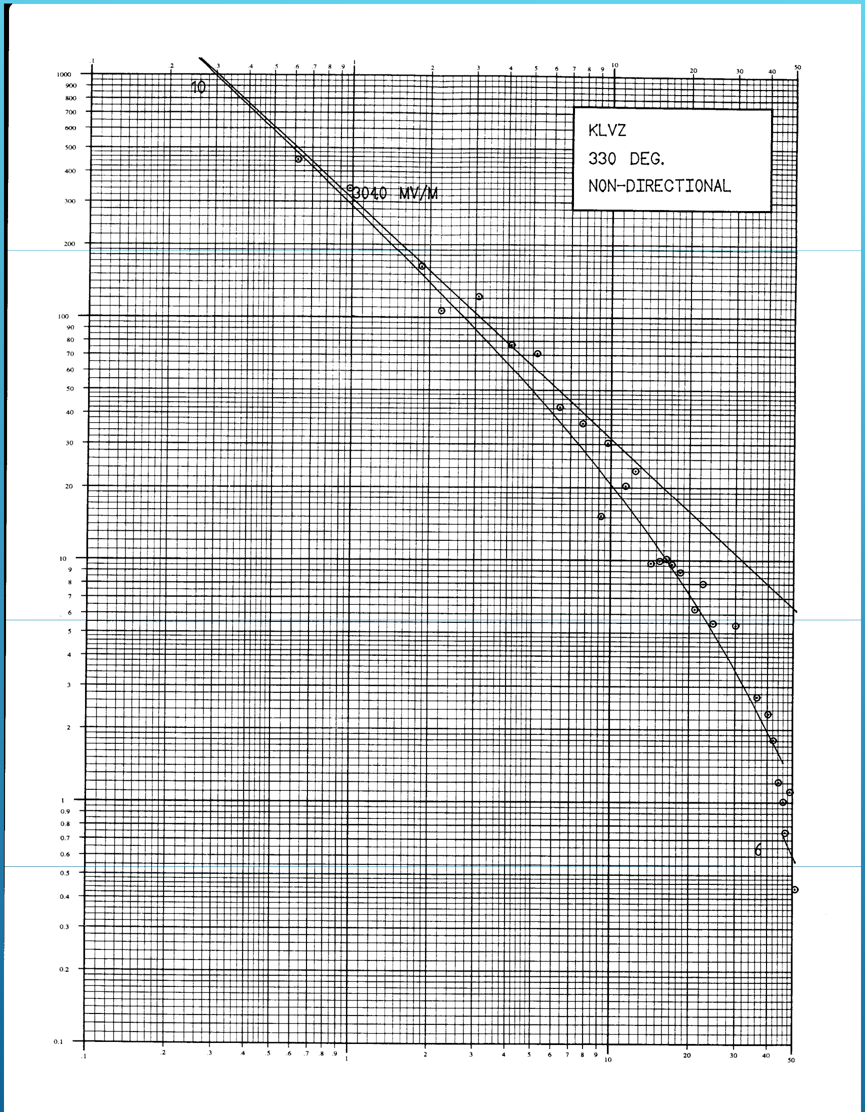
KLVZ – Ruby Hill Site -- 330 Degree Measurements



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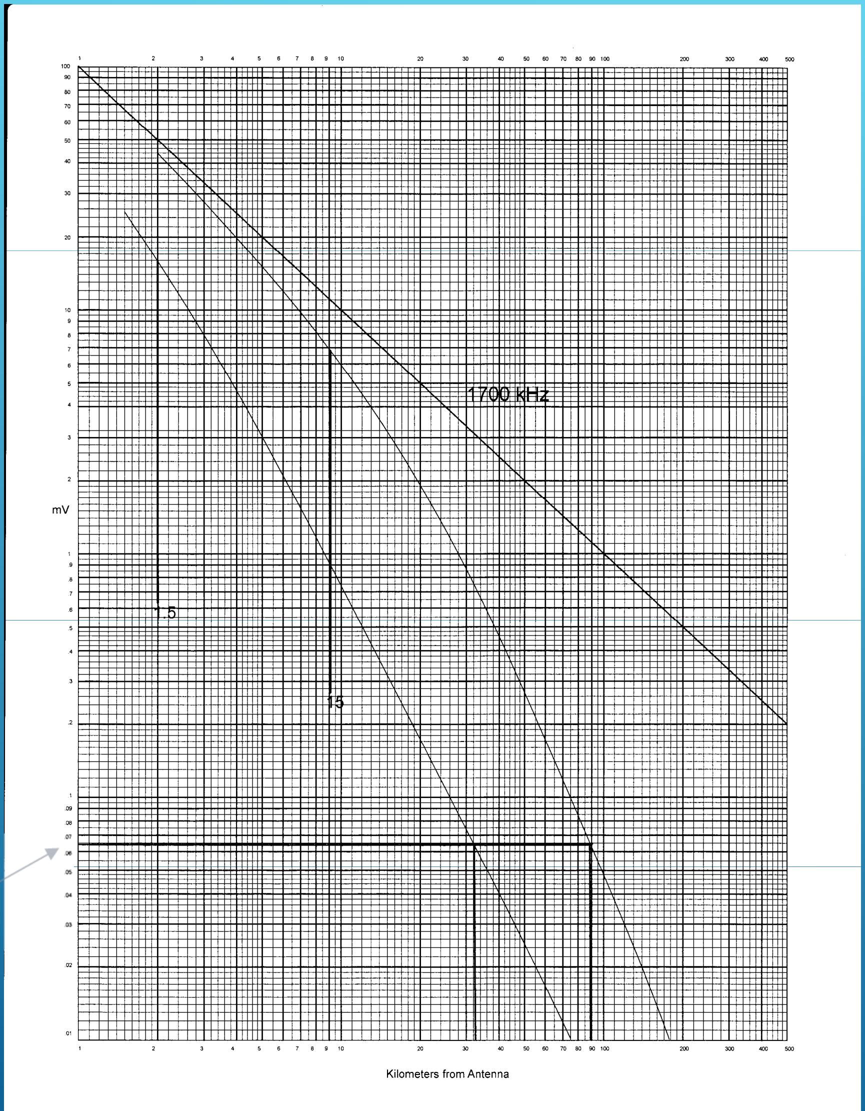
To find the IDF for 100 watts, divide 100 by 1000, take the square root and multiply by the 1 kW IDF as follows:

$$\sqrt{\frac{100}{1000}}x245 = 77\ mV/m$$

To find the distance to 50 uV (0.05 mV) on the graph, divide 50 by 77/100, like this:

$$\frac{50}{0.77} = 64.9\ uV/m$$

Now find 64.9 uV (0.064 mV) on the graph.



So what difference does it make?

For a 100-watt station using our hypothetical 80-foot vertical, the distance to a 50 uV (S-9) field strength is:

15 mS/m – 90 km (56 mi.)

1.5 mS/m – 32 km (19.8 mi.)

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Ground conductivity makes a BIG difference in the received groundwave signal over a given path.

Because it affects the amount of signal reflected, it also has a significant effect on the received skywave signal, but this can be overcome with a good radial ground system.

Questions?

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